UNITED STATES DEPARTMENT OF AGRICULTURE
RURAL ELECTRIFICATION ADMINISTRATION
WASHINGTON 25, D. C.

TELEPHONE ENGINEERING MEMORANDUM 519

August 28, 1951

SUBJECT: Transmission Criteria

In the past year there has been considerable discussion of the transmission considerations to be used in the design of REA-financed telephone systems. Since these systems must tie in with the telephone system of the United States, it is obvious that any basis for transmission must be closely related to those upon which the Bell system plant is based, since the backbone toll system owned by the Bell system is designed for use with their exchange standards. During this period the basis for transmission design has been in a state of flux. Many changes were being made and were contemplated. These changes were as a result of the revised nationwide toll switching plan, improvements in carrier, particularly in the reduction of cost of carrier equipment, and other technological improvements. The following information was prepared in conjunction with the Bell system and will apply to the design of REA-financed exchange plant. It supersedes the information previously promulgated on this subject in the REA Telephone Engineering Manual. All loop resistances referred to herein include only that of the external conductors and all battery supply is assumed to be 48 volt.

The apparent simplicity of the following criteria should not be construed as giving the engineer a carte blanche to ignore transmission difficulties which might result from the application of these rules and which would be readily apparent to a transmission engineer.

GENERAL

Under the practices described herein, the design of tributary trunks, the design of intertoll trunks and the design of subscribers' loops will, generally, be made independent of each other.

SUBSCRIBERS' LOOPS

1. The general basis for design will be loop resistance.

2. On loops up to 1000 ohms, transmission with the common battery sets of the Western Electric Company, type 302 or equivalent, shall be considered as adequate.

3. Loading shall be applied under the following conditions:

Cable Gauge	On Loops Entirely of Cable in Excess of
24	16 Kilofeet (3.03 Mi.)
22	20 Kilofeet (3.79 Mi.)
19	26 Kilofeet (4.92 Mi.)

Loading shall be applied on loops consisting of both cable and open wire when the combination of cable lengths and wire lengths exceed those given in the following table. The loop d.c. resistances are included for the convenience of the engineer and do not include the resistance of subscriber's telephone.

Cable		OPEN WIRE											
		Steel Wire			Copperweld Wire								
Ga.	Length To Nearest KF	109HTL 135			104 - 40%			104 - 30%			080 - 40%		
		Wire Loop Length		Total Loop Resis.	Wire Loop Length		Total Loop Resis.	Wire Loop Length		Total Loop Resis.	Wire Loop Length		Total Loop Resis.
		KF	Mi.		KF	Mi.		KF	Mi.				
24	12	14	2.6	825	62	11.7	928	42	7.9	895	42	7.9	969
24	13	10	1.9	830	45	8.5	890	32	6.0	875	32	6.0	936
24	14	6	1.1	840	32	6.1	885	22	4.2	870	22	4.2	908
24	15	4.	0.8	850	19	3.6	877	12	2.3	865	12	2.3	875
22	12	30	5.7	830	96	18.2	865	62	11.7	799	62	11.7	905
22	13	26.5	5.0	810	83	15.7	830	54	10.0	780	54	10.0	861
22	14	24.3	4.6	800	74	14.0	815	50.6	9.5	780	50.6	9.5	852
22	15	19	3.6	775	62	11.7	790	43	8.1	770	43	8.1	843
22	16	16	3.0	750	52	9.8	770	36	6.8	755	36	6.8	816
22	17	13	2.5	740	46	8.7	775	29	5.5	740	29	5.5	789
22	18	10	1.9	725	32	6.1	740	22	4.2	725	22	4.2	763
22	19	7	1.3	710	21.7	4.0	710	15	2.8	710	15	2.8	732
22	20	5	0.9	710	11	2.1	695	-	-	-	-	-	-
22	21	4	0.8	730	-	-	-	-	-	-	-	-	-
19	12	27	5.1	597	108	20.4	730	80	15.1	725	80	15.1	863
19	13	24	4.5	570	107	20.2	740	77	14.6	720	77	14.6	856
19	14	22	4.2	555	106	20.0	750	71.7	13.6	705	71.7	13.6	830
19	15	19	3.6	530	100	18.9	740	66	12.5	680	66	12.5	797
19	16	17	3.2	515	92	17.4	720	60	11.3	660	60	11.3	762
19	17	15	2.8	500	88	16.6	715	54.5	10.2	640	54.5	10.2	731
19	18	12	2.3	480	78	14.8	685	50	9.5	630	50	9.5	719
19	19	10	1.9	470	69	13.1	660	44	8.3	610	44	8.3	683
19	20	8	1.5	455	64	12.1	650	40	7.6	600	40	7.6	671
19	21	6	1.1	440	55	10.4	625	35	6.6	585	35	6.6	644
19	22	4	0.8	435	45	8.5	595	27	5.1	550	27	5.1	597
19	23	-	-	-	35	6.6	565	23	4.3	540	23	4.3	579
19	24	-	-	-	23	4.4	525	16.7	3.1	515	16.7	3.1	545
19	25	-	-	-	21	4.0	510	10	2.0	495	10	2.0	514

4. It should be noted that generally loops in excess of 1000 ohms require special central office equipment for signalling purposes. This fact, coupled with transmission considerations, makes it imperative that the project engineer design a system with an absolute minimum of subscriber loops in excess of 1000 ohms.

Although rules 1 and 2 state that transmission on a common battery basis (using W. E. Co. 302 set or equivalent) is to be considered satisfactory on loops of 1000 ohms and less, it should not be construed that transmission on loops in excess of this limit will necessarily be unsatisfactory. With certain types of outside plant facilities such as all open wires, the 1000 ohm loop resistance may be materially exceeded with common battery sets of the W. E. Co. 302 type or equivalent and adequate transmission will still be provided.

The Western Electric Company 500 series set is a common battery telephone set which will provide adequate transmission on loops well in excess of 1000 ohms. Unfortunately, it is impossible to predict when a set with comparable transmission characteristics will be available for use by the independent industry. The alternative to the use of a 500 series type set on long loops is, of course, local battery equipment. Such equipment introduces additional maintenance cost which many of our borrowers can ill-afford. The excess maintenance charges in many cases will often exceed the annual charges on the investment required to improve outside plant to a degree which will eliminate the need for local battery equipment.

Therefore on those loops in excess of 1000 ohms <u>which include a significant amount of cable</u>, consideration should be given to the following:

(a) If the number of subscribers involved is relatively few and it is uneconomical to provide adequate transmission through outside plant improvements, a somewhat less desirable grade of transmission for these few subscribers will be acceptable until such time as improved common battery sets become available. This exception is based on the premise that only in very rare cases will a subscriber at the extremities of one exchange area call over the toll network a subscriber similarly located in another area.

(b) That the seriousness of inadequate subscriber loop transmission on system performance may be minimized where trunk losses are less than the accepted average value.

(c) In some cases it will be necessary as a last resort to use local battery anti-sidetone sets. This should be done only after thorough investigation of all alternatives. In the past, many area coverage designs have been received which included a large percentage of local battery sets. The design engineer in his explanation stated that local battery sets were to be installed initially with the assumption that they would later be retired in favor of sets similar to the W. E. Company 500 series when such instruments became available. While such an assumption may be sound where large independents or the Bell system is concerned, past experience in the independent industry indicates

that the borrower will not be in a position to effect such a retirement and that the material with its high maintenance costs will remain in the system indefinitely.

TRIBUTARY TRUNKS

All tributary trunk losses (including any tandem arrangement) should be as low as practicable, consistent with economical design. Insofar as possible, the loss in these trunks should not exceed 4 db including repeating coils and other equipment in the trunk circuit. Generally, when the exchange is connected directly to a toll center, the 4 db trunk limit can be met without too much difficulty. In the case of a tandem operation, the 4 db loss to the toll center should be exceeded only after thorough investigation of all possibilities for improvement, including the use of repeater and carrier facilities.

INTER-TOLL TRUNKS

The design of inter-toll trunks is considered to be a special application of transmission work and is not covered by this memorandum.

INTRA-SYSTEM CALLS

The intra-system trunking scheme shall be designed so that on any possible connection between two subscribers, the sum of the over-all losses of trunk and switching facilities shall not exceed 12 db.

Additional information on transmission, including data for making transmission calculations, will be published in the REA Telephone Engineering and Construction Manual.

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